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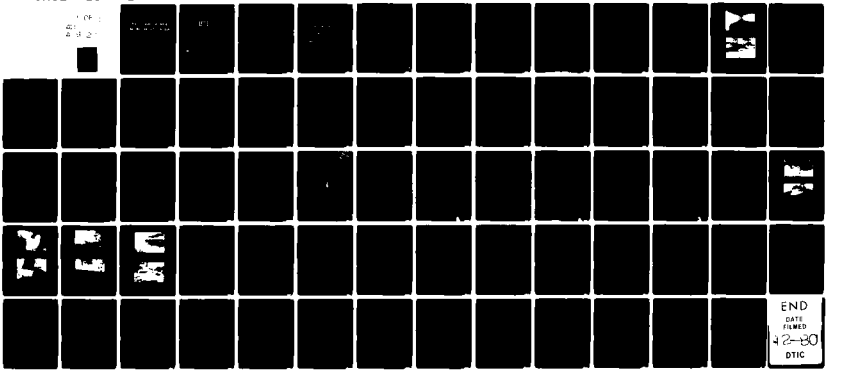

JAMES RIVER BASIN

Name Of Dam: LOWER BEAVER POND DAM

Location: CHESTERFIELD COUNTY, VIRGINIA

Inventory Number: VA. NO. 04106

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

PREPARED FOR

NORFOLK DISTRICT CORPS OF ENGINEERS
803 FRONT STREET
NORFOLK, VIRGINIA 23510

BY

SCHNABEL ENGINEERING ASSOCIATES, P.C./
J. K. TIMMONS AND ASSOCIATES, INC.

September, 1980

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20. Abstract

Pursuant to Public Law 92-367, Phase I Inspection Reports are prepared under guidance contained in the recommended guidelines for safety inspection of dams, published by the Office of Chief of Engineers, Washington, D. C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general conditions of the dam is based upon available data and visual inspections. Detailed investigation and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

Based upon the field conditions at the time of the field inspection and all available engineering data, the Phase I report addresses the hydraulic, hydrologic, geologic, geotechnic, and structural aspects of the dam. The engineering techniques employed give a reasonably accurate assessment of the conditions of the dam. It should be realized that certain engineering aspects cannot be fully analyzed during a Phase I inspection. Assessment and remedial measures in the report include the requirements of additional indepth study when necessary.

Phase I reports include project information of the dam and appurtenances, all existing engineering data, operational procedures, hydraulic/hydrologic data of the watershed, dam stability, visual inspection report and an assessment including required remedial measures.

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JAMES RIVER BASIN

NAME OF DAM: LOWER BEAVER POND DAM
LOCATION: CHESTERFIELD COUNTY, VIRGINIA
INVENTORY NUMBER: VA. NO. 04106

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(6) PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM.
Lower Beaver Pond Dam,
(Inventory Number VA04106),
James River Basin,
Chesterfield County, Virginia.
Phase I Inspection Report.

PREPARED FOR

NORFOLK DISTRICT CORPS OF ENGINEERS
803 FRONT STREET
NORFOLK, VIRGINIA 23510

(10) Ray E. Martin
James A. Walsh

BY

SCHNABEL ENGINEERING ASSOCIATES, P.C./
J. K. TIMMONS AND ASSOCIATES, INC.

(15) DACW65-79-D-0004

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Appendices

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D. C., 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

BRIEF ASSESSMENT OF DAM

Name of Dam:	Lower Beaver Pond Dam
State:	Virginia
Location:	Chesterfield County
USGS QUAD Sheet:	Chesterfield
Coordinates:	Lat 37° 27.2' Long 77° 34.1'
Date of Inspection:	May 29, 1980

Lower Beaver Pond Dam is a zoned earthfill structure about 400 ft long and 23 ft high. The principal spillway consists of a rectangular concrete inlet and an outlet pipe which extends through the structure. The dam is a small size structure and is assigned a "significant" hazard classification. The dam is located on Beaver Pond Creek approximately three miles southwest of Richmond, Virginia. The lake is used for recreation and is owned and maintained by Mr. Wallace H. LaPrade.

Based on the criteria established by the Department of the Army, Office of the Chief of Engineers (OCE), the appropriate Spillway Design Flood (SDF) is the 100 year flood. The spillway will pass 15 percent of the Probable Maximum Flood (PMF) or 150 percent of the SDF. The spillway is rated adequate.

The visual inspection did not reveal any problems which would require immediate attention. An emergency operation and warning plan should be developed.

The following routine maintenance and observation functions should be initiated as part of an annual maintenance program:

1) The eroded area along the left downstream slope should be backfilled with compacted soil and seeded in order to prevent further erosion.

2) The plunge pool should be repaired by removing sediment buildup and protecting against further sloughing of the channel.

3) All trees present on the embankment should be cut to ground level yearly during maintenance operations.

4) Debris should be removed from the overflow intake as it accumulates.

5) Animal burrowing observed above the outlet structure should be prevented. Existing holes should be backfilled with compacted soil.

6) A staff gage should be installed to monitor water levels.

Prepared by:

SCHNABEL ENGINEERING ASSOCIATES, P.C./
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Colonel, Corps of Engineers
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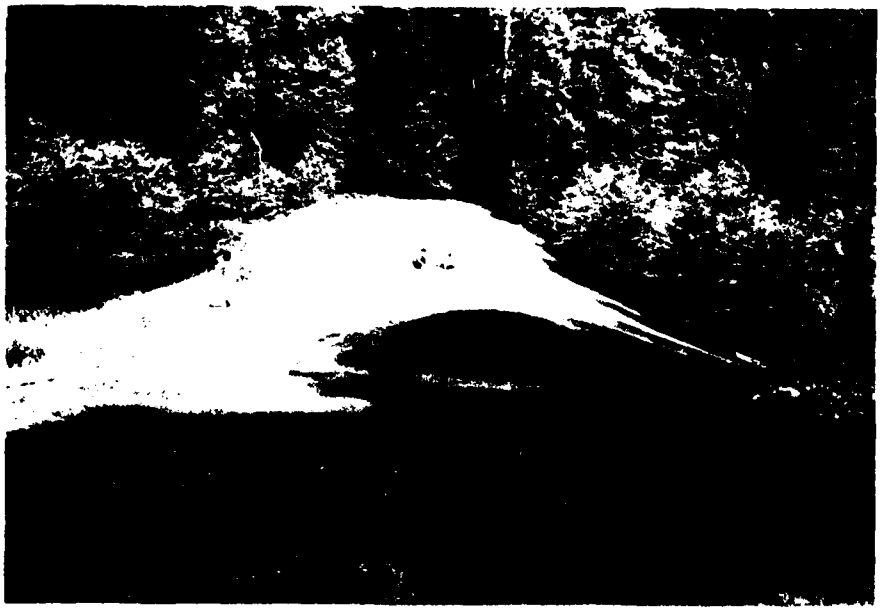
Recommended by:

Original signed by
JACK G. STARR

Jack G. Starr, P.E., R.A.
Chief, Engineering Division

Date: SEP 25 1980

Reservoir



Top of Dam

Overview Photographs

SECTION 1 - PROJECT INFORMATION

1.1 General:

1.1.1 Authority: Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a national program of safety inspection of dams throughout the United States. The Norfolk District has been assigned the responsibility of supervising the inspection of dams in the Commonwealth of Virginia.

1.1.2 Purpose of Inspection: The purpose is to conduct a Phase I inspection according to the Recommended Guidelines for Safety Inspection of Dams (Reference 1, Appendix VI). The main responsibility is to expeditiously identify those dams which may be a potential hazard to human life or property.

1.2 Project Description:

1.2.1 Dam and Appurtenances: Lower Beaver Pond Dam is a zoned earthfill structure approximately 400 ft long and 23 ft high at the low point on the dam*. The crest of the dam is 40 ft wide, and side slopes are approximately 3 horizontal to 1 vertical (3:1) on the upstream slope and 2.5 horizontal to 1 vertical (2.5:1) on the downstream slope. The crest of the dam at the low point is at elevation 178 msl.

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*Height is measured from the top of the dam to the downstream toe at the centerline of the stream.

The dam is keyed into the foundation, however, there is no internal drainage system. Existing vegetation on the embankment slopes provide adequate slope protection.

The top of the dam was designed to conform to a roadway section and is constructed on a vertical curve (Plate No. 4, Appendix I).

The principal spillway consists of a 15 ft x 10 ft reinforced concrete overflow wier box. The box is connected to a 72 inch diameter reinforced concrete outlet pipe which runs through the dam. The crest of the overflow wier is at an elevation of 168 msl which established the normal pool elevation. A 24 inch diameter sluice gate in the wier box at an invert elevation of 158 msl is used to lower the pool level. The outlet pipe has a length of 102 ft and an invert elevation at the outlet structure of 155 msl (Plate No. 3, Appendix I).

1.2.2 Location: Lower Beaver Pond Dam is located on Beaver Pond Creek approximately three miles southwest of Richmond, Virginia. (Plate No. 1, Appendix I).

1.2.3 Size Classification: The dam is classified as a "Small" size structure because of the lake maximum storage potential.

1.2.4 Hazard Classification: The dam is located in a suburban area, and based upon the proximity of several inhabited dwellings located one-half mile downstream, the dam is assigned a "significant" hazard classification. The hazard classification used to categorize a dam is a function of location only, and has nothing to do with its stability or probability of failure.

1.2.5 Ownership: The dam is owned by Mr. Wallace H. LaPrade.

1.2.6 Purpose: Recreation.

1.2.7 Design and Construction History: The dam was designed and constructed under the supervision of LaPrade Brothers, Inc., Civil Engineers & Surveyors of Richmond, Virginia. The structure was constructed by Shoosmith Brothers and completed in 1969.

1.2.8 Normal Operational Procedures: The principal spillway is ungated; therefore, water rising above the crest of the overflow drop inlet is automatically discharged downstream. Normal pool is maintained at about elevation 168.2 msl, which is slightly above the crest of the inlet.

1.3 Pertinent Data:

1.3.1 Drainage Area: The drainage area is 1.96 square miles, of which 1.79 square miles is controlled by the upper dam.

1.3.2 Discharge at Dam Site: According to Mr. Wallace LaPrade, the maximum known flood at the dam site occurred in October 1979 with a maximum pool elevation of 172 msl, which corresponds to a 540 CFS discharge.

Principal Spillway Discharge:

Pool Elevation at Crest of Dam (elev 178msl) 645 CFS

1.3.3 Dam and Reservoir Data: See Table 1.1, below:

TABLE 1.1 - DAM AND RESERVOIR DATA

Item	Reservoir				
		Storage			
	Elevation feet msl	Area Acres	Volume Acre Feet	Watershed* Inches	Length Miles
Crest of Dam	178	32.5	266	2.54	.4
Principal Spillway Crest	168	20.3	61	.58	.4
Streambed at Downstream Toe of Dam	155	-	-	-	-

* Total drainage including upper impoundment

SECTION 2 - ENGINEERING DATA

2.1 Design: The dam was designed and constructed under the direction of LaPrade Brothers, Inc., of Richmond, Virginia. Design drawings are available at the office of LaPrade Brothers, Inc., Three West Cary Street, Richmond, Virginia, 23220.

A subsurface investigation was conducted at the site by Froehling and Robertson, Inc., during the initial design stages. The investigation consisted of drilling 24 test borings, 12 of which included rock coring. The test boring location plan and logs for those test borings drilled along the centerline of the dam (Borings No. 7 thru 12) are included in Appendix IV. Boring logs are available at LaPrade Brothers' office.

The dam is a zoned, compacted earthfill embankment. A section through the dam is provided on Plate No. 3, Appendix I. A 225 ft$^{\pm}$ long and 20 ft wide core extending approximately 4 ft below the ground surface was constructed. Grainsize requirements for the core material (Plate No. 3, Appendix I) indicate that this material was to consist of mixtures of fine sand, silt and clay. According to Mr. Wallace LaPrade, the core material consisted of clay soils excavated from nearby roads in the surrounding housing development. Although specifications for the remaining embankment fill materials were not provided, laboratory test data (Appendix V) for samples from Borings No. 19 thru 24 indicate that soils in the reservoir area were predominately non-plastic coarse-grained soils. Mr. LaPrade stated that the embankment shell was constructed with clayey soils

similar to the clay core except that this fill probably included more granular materials. All fill placed was compacted with a sheepsfoot roller and density tests performed to determine the percent compaction. The upstream and downstream slopes were designed at 2.5H:1V and 2H:1V, respectively. However, Mr. LaPrade stated that the slopes were actually constructed not as steep in attempt to facilitate their maintenance.

A review of test boring data indicates the dam is founded on overburden and includes a cutoff trench which extends into silty clay, sand, and gravel soils near Borings No. 9 and 10, but otherwise into residual soils and decomposed bedrock. Details of the cutoff are provided on Plate No. 3 of Appendix I. An internal drainage system was not included in design.

The principal spillway was designed as a drop inlet structure consisting of a reinforced concrete overflow weir and a 72 inch diameter reinforced concrete outlet pipe. A 24 inch diameter drain gate was installed on the inlet structure for purposes of lowering the pool. Details are shown on Plate No. 3, Appendix I. Four (4) anti-seep rings or collars were included in order to prevent piping of soil along the 72 inch pipe.

2.2 Construction: Construction records were not available for this structure.

2.3 Evaluation: Design drawings are representative of the structure and hydrologic and hydraulic calculations are sufficient. There is sufficient information to evaluate the foundation conditions but not the embankment stability.

SECTION 3 - VISUAL INSPECTION

3.1 Findings: At the time of inspection, the dam was in good condition. Field observations are outlined in Appendix III.

3.1.1 General: An inspection was made on May 29, 1980 and the weather was fair with a temperature of 75°F. The pool and tailwater levels at the time of inspection were 168.2 and 156 msl, respectively. This corresponds to normal pool and tailwater elevations. Ground conditions were dry at the time of inspection. No previous inspection reports were available.

3.1.2 Dam and Spillway: The upstream embankment slope was grassed and well maintained, however, the downstream slope was covered with 3 ft± high grass (Photo No. 2, Appendix II). This grass was cut and well maintained during a July 16, 1980 inspection. Small trees ranging from ½ inch to 2 inches in diameter are present just above pool level on the upstream slope (Photo No. 1, Appendix II) and around the outlet structure on the downstream slope (Photo No. 2, Appendix II). Field measurements indicate the upstream slope is 3H:1V and the downstream slope is 2.5H:1V. An unpaved road consisting of fine to coarse sand base surface traverses the crest of the dam.

The only surface erosion noted on the embankment exists along the left downstream slope as shown on Sheet 1 of Appendix III. A 65 to 75 ft± long erosion gulley, which is about 1 to 2 ft wide and 1 to 3 ft deep, developed as a result of extremely heavy rainfall in October, 1979. No seepage was observed along the downstream slope.

Both abutments were well vegetated and no erosion was noted along the embankment abutment contacts. Surface soils in the surrounding area consist of Pleistocene terrace deposits, which include assorted combinations of sand, silt, clay, and gravel materials. These deposits are underlain by the Petersburg Granite. Bedrock was not exposed at the site. No faults were observed in the field during this inspection and geologic maps of the area do not show the presence of faults in the immediate vicinity.

The overflow inlet and outlet pipe showed no signs of deterioration and were functioning properly at the time of inspection. Some debris was present along the edge of the overflow inlet. The drain gate was reportedly in operational condition; however, the drain outlet has been modified to increase the discharge elevation by 3 ft (See Sheet 2, Appendix III and Photograph No. 4, Appendix II).

The plunge pool has undergone some erosion as evidenced by the sloughing banks and sediment buildup (Photographs Nos. 7 and 8 and Sheet 1, Appendix III). Several animal burrows were noted along the outlet pipe.

3.1.3 Reservoir Area: The reservoir area was free of debris and the perimeter was wooded (Overview Photographs, Page 5). The reservoir is located in a valley with side slopes at approximately 3H:1V. No sediment build-up was observed.

3.1.4 Downstream Area: The downstream channel is located in a narrow wooded valley with heavy underbrush (Photograph No. 6, Appendix II). Approximately one-half mile downstream there are two dwellings about 10 ft above the streambed, and approximately one-quarter mile downstream Va. Route 360 (primary highway) crosses the stream.

3.1.5 Instrumentation: No instrumentation (monuments, observation wells, piezometers, etc.) was encountered for the structure. A staff gage was not observed.

3.2 Evaluation: Overall, the dam was in good condition at the time of the inspection.

3.2.1 Dam and Spillway: Corrective maintenance and vegetative control are performed routinely. Trees presently growing on the embankment should be cut to the ground. The eroded area observed along the left downstream slope should be backfilled with compacted soil and seeded in order to prevent further erosion. The plunge pool should be repaired by removing sediment buildup and protecting against further sloughing of the channel. Animal burrowing should be prevented on the embankment and existing holes backfilled with compacted soil. Debris should be removed from the edge of the overflow intake. A staff gage should be installed to monitor water levels.

3.2.2 Downstream Area: A breach in Lower Beaver Pond Dam during extreme flooding could create a hazard to the downstream dwellings.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 Procedures: Lower Beaver Pond Dam is used for recreational purposes. The normal pool elevation (about 168.2 msl) is maintained by a wier box acting as the principal spillway. Water automatically flows over the inlet crest as the pool level rises above elevation 168.0 msl.

4.2 Maintenance of Dam and Appurtenances: Maintenance is the responsibility of the Owner. Maintenance consists of routine inspection and the removal of debris, mowing of vegetative cover, and repair as required. Routine maintenance is performed.

4.3 Warning System: At the present time there is no warning system or evacuation plan for the dam.

4.4 Evaluation: The dam and appurtenances are in good operating condition, and maintenance of the dam is adequate. Records should be maintained of all maintenance and operational procedures for future reference. An emergency operation and warning plan should be developed. It is recommended that a formal emergency procedure be prepared and furnished to all operating personnel. This should include:

a) How to operate the dam during an emergency.

b) Who to notify, including public officials, in case evacuation from the downstream area is necessary.

SECTION 5 - HYDRAULICS/HYDROLOGIC DATA

5.1 Design: Lower Beaver Pond Dam was designed as a single-purpose dam and hydrologic and hydraulic data are available including stage-storage and stage-discharge curves.

5.2 Hydrologic Records: There are no records available.

5.3 Flood Experience: According to Mr. Wallace LaPrade, a maximum pool elevation of 172 msl occurred in October, 1979.

5.4 Flood Potential: In accordance with the established guidelines, the Spillway Design Flood (SDF) is based on the estimated "Probable Maximum Flood" (flood discharges that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region), or fractions thereof. The Probable Maximum Flood (PMF), ½ PMF and 100 year hydrographs for the local area were developed by the SCS method (Reference 5, Appendix VI). Precipitation amounts for the flood hydrographs of the PMF and 100 year flood were taken from U. S. Weather Bureau Information (References 6 and 7, Appendix VI). Appropriate adjustments for basin size and shape were accounted for. The local area hydrographs were combined with the discharge hydrographs for the Upper Beaver Pond Dam (determined in a previous Phase I report), and these hydrographs were routed through the reservoir to determine maximum pool elevations.

5.5 Reservoir Regulations: For routing purposes, the pool at the beginning of flood was assumed to be at elevation 168 msl. Reservoir stage-storage data and stage-discharge data were determined from the design report and verified. Floods were routed through the reservoir using the principal spillway discharge up to a pool storage elevation of 178 msl and combined principal spillway and non-overflow section for pool elevations above 178 msl.

5.6 Overtopping Potential: The predicted rise of the reservoir pool and other pertinent data were determined by routing the flood hydrographs through the reservoir as previously described. The results for the flood conditions PMF, ½ PMF, and 100 year flood are shown in the following Table 5.1:

Table 5.1 RESERVOIR PERFORMANCE

		Hydrograph		
	Normal Flow	100 year	½ PMF	PMF
Peak Flow, CFS				
Inflow	2	1103	5520	11040
Outflow	2	580	5520	11040
Maximum Pool Elevation Ft, msl	168.2	173.4	182.60	184.5
Non-Overflow Section (elev 178 msl)				
Depth of Flow, Ft.	-	-	4.6	6.5
Duration, Hours	-	-	5	9.5
Velocity, fps	-	-	8	9.7
Tailwater Elevation Ft, msl	156	160.5	173.5	178.5

5.7 Reservoir Emptying Potential: A 24 inch diameter gate at centerline elevation 159 msl is capable of draining the reservoir through the outlet culvert to elevation 161 msl. Assuming that the lake is at normal pool elevation (168.2 msl) and there is 2 cfs inflow, it would take approximately one day to lower the reservoir to elevation 161 msl, or a 7 feet per day drawdown rate.

5.8 Evaluation: The U. S. Army, Corps of Engineers, guidelines indicate the appropriate Spillway Design Flood (SDF) for a small size, significant hazard dam is the ½ PMF to 100 year flood. Because of the risk involved, the 100 year flood has been selected as the SDF. The spillway will pass 15 percent of the PMF (150 percent of the SDF).

Hydrologic data used in the evaluation pertains to present day conditions with no consideration given to future development.

SECTION 6 - DAM STABILITY

6.1 Foundation and Abutments: The dam is located along the eastern edge of the Piedmont physiographic province of Virginia. The site is underlain by a thin veneer of Pleistocene terrace deposits, which typically consist of a heterogenous mixture of sand, silt, clay, and gravel materials. Recent alluvial deposits of similar composition occur along the stream floodplain. The above described materials are underlain by residual soils derived from the in-place weathering of the Petersburg Granite. These residual soils usually consist of micaceous sands and silts throughout the Richmond area. The Petersburg Granite consists basically of biotite-microcline granite but also includes quartz monzonite and biotite gneiss.

A cutoff trench exists beneath the dam. If the cutoff was excavated to a uniform elevation of about 150 to 151 msl as designed, it appears that only a partial cutoff was made as boring data indicate about 6 ft of granular overburden materials below this level. An internal drainage system was not constructed. No permeability test data was included with the information reviewed. However, subsurface and laboratory test data indicate that the overburden materials probably possess low to high natural permeabilities. Joints or fractures often occur in the Petersburg Granite, and permeabilities are directly related to the degree of fracturing as well as the degree of weathering. Core recoveries of 50 to 100 percent were recorded on the test boring logs, which indicate the potential for water to pass through some of the bedrock encountered.

Gradual consolidation of underlying soils would be expected during application of fill materials. The underlying soils probably had fully

consolidated under the applied load not long after completion of construction. Based upon the performance history of this dam and the test boring data, a stable foundation is assumed.

6.2 Embankment:

6.2.1 Materials: Based upon the laboratory test data and conversations with Mr. Wallace LaPrade the cutoff and interior core was apparently constructed with silty clay soils which probably classified as CL in accordance with the Unified Soil Classification System. The remainder of the embankment was constructed with more permeable mixtures of sand, silt, and clay which would probably classify as SM, SC, and ML. Materials in both zones were compacted with a sheepsfoot roller and density tests were performed to determine the percent compaction.

6.2.2 Subdrains and Seepage: There is no internal drainage system for this structure. Four (4) anti-seepage rings or collars were included around the principal spillway pipe to prevent the piping of fill materials. No seepage was observed during the field inspection.

6.2.3 Stability: There are no stability calculations for this structure. The dam is 23 ft high and has a crest width of 40 ft. The upstream slope is approximately 3H:1V, while the downstream slope is about 2.5H:1V.

Although design drawings indicate the dam is a zoned structure, information provided by the Owner indicates the structure is essentially homogeneous with the "shell" materials being somewhat more granular than the clay core. The dam is subjected to sudden drawdown because the approximate reservoir drawdown rate of 7 ft per day exceeds the critical rate of 0.5 ft per day for earth dams. According to the guidelines presented in Design of Small Dams, U.S. Department of the Interior Bureau of Reclamation,

for small homogeneous dams with a stable foundation subjected to drawdown and composed of CL, ML, SC to SM materials, the recommended slopes range from 2H:1V to 2.5H:1V for the downstream slope and 3H:1V to 3.5:1V for the upstream slope. Based upon existing slopes of 3H:1V for the upstream slope and 2.5H:1V for the downstream slope, both slopes are considered to be adequate. The recommended crest width is 14.6 ft, therefore, the existing crest width is also considered to be adequate.

6.2.4 Seismic Stability: The dam is located in Seismic Zone 2. Therefore, according to the Recommended Guidelines for Safety Inspection of Dams, the dam is considered to have no hazard from earthquakes provided static stability conditions are satisfactory and conventional safety margins exist.

6.3 Evaluation: An accurate check on the stability of this structure cannot be made since stability analyses were not performed for design, and construction records are not available. However, available test boring data and the visual inspection indicate a stable foundation. Based upon the Bureau of Reclamation guidelines, the slopes are adequate and the crest width is about 2.7 times greater than the recommended width. Since no undue settlement, cracking, sloughing or seepage was noted at the time of inspection, it appears that the embankment is adequate for maximum control storage with water at elevation 168.2 msl.

No seepage was observed during the inspection but based upon the design data only a partial cutoff may have been constructed for the dam. No boils or soft areas were observed below the downstream toe which would indicate excessive seepage through the foundation. Based upon the performance history of the dam and the field observations, this is not believed to be a problem.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment: Lower Beaver Pond Dam at the time of inspection appeared to be in good condition. The appropriate SDF for this dam is the 100 year flood. The spillway will pass 15 percent of the PMF (150 percent of the SDF) without overtopping. The spillway is judged adequate.

The visual inspection revealed no findings that proved the dam to be unsound. A routine maintenance program exists for the structure and maintenance is considered adequate. Both the upstream and downstream embankment slopes meet the requirements recommended by the U. S. Bureau of Reclamation (Reference 1, Appendix VI) while the crest width is 2.7 times greater than the recommended width.

7.2 Recommended Remedial Measures:

7.2.1 Emergency Operation and Warning Plan: It is recommended that a formal emergency procedure be prepared, prominently displayed, and furnished to all operating personnel. This should include:

1) How to operate the dam during an emergency.

2) Who to notify, including public officials, in case evacuation from the downstream area is necessary.

7.3 Required Maintenance:

7.3.1 The eroded area along the left downstream slope should be backfilled with compacted soil and seeded in order to prevent further erosion.

7.3.2 The plunge pool should be repaired by removing sediment buildup and protecting against further sloughing of the channel.

7.3.3 All trees present on the embankment should be cut to ground level yearly during maintenance operations.

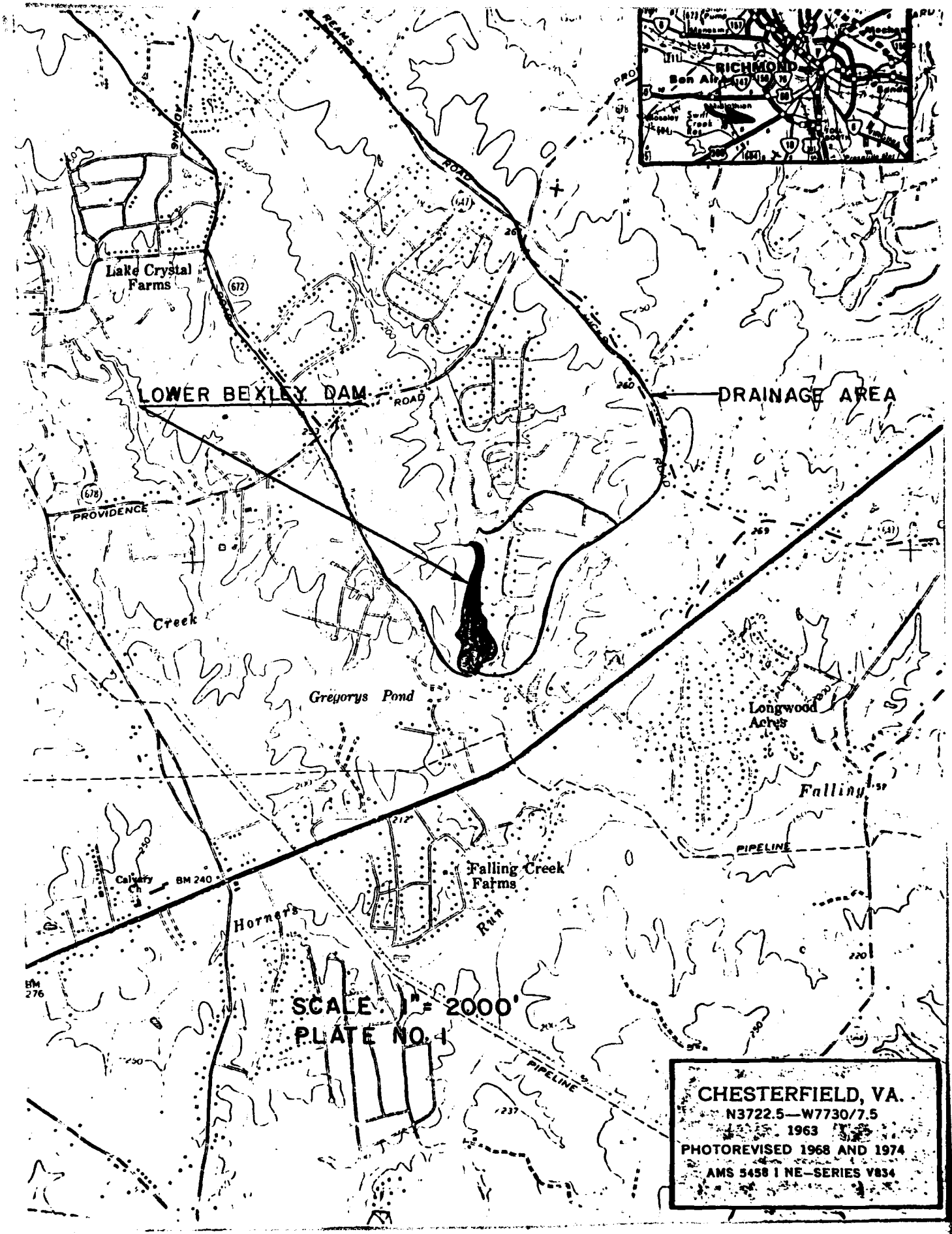
7.3.4 Debris should be removed from the overflow intake as it accumulates.

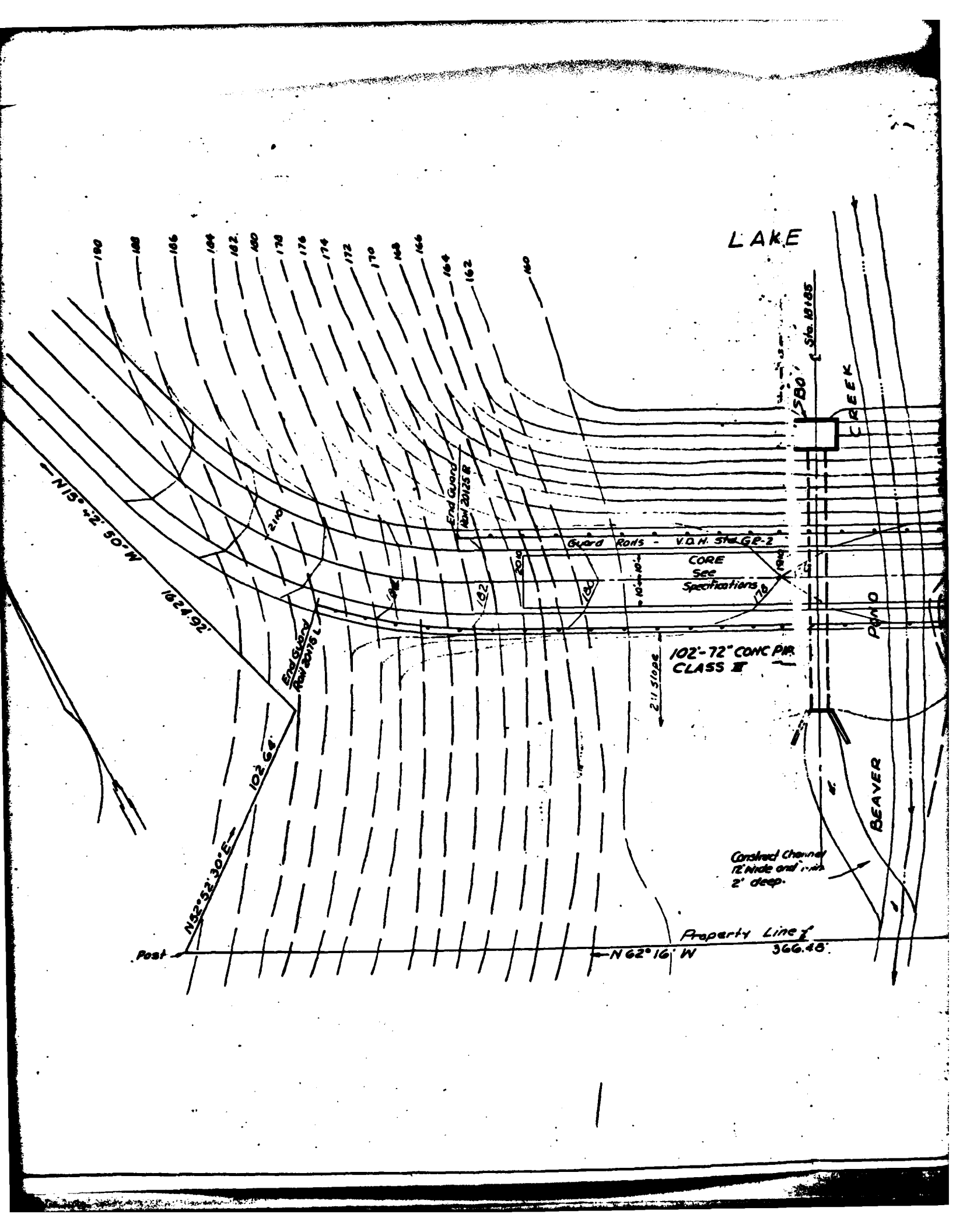
7.3.5 Animal burrowing observed above the outlet structure should be prevented. Existing holes should be backfilled with compacted soil.

7.3.6 A staff gage should be installed to monitor water levels.

APPENDIX I

MAPS AND DRAWINGS


RICHMOND
Ben Ai
Lake Crystal Farms
672
LOWER BEXLEY DAM
ROAD
DRAINAGE AREA
678
PROVIDENCE
Creek
Gregorys Pond
Longwood Acres
Falling
PIPELINE
Falling Creek Farms
Calvary Ch
BM 240
Horners
Run
BM 276
SCALE 1" = 2000'
PLATE NO. 1
PIPELINE
CHESTERFIELD, VA.
N3722.5—W7730/7.5
1963
PHOTOREVISED 1968 AND 1974
AMS 5458 I NE—SERIES V834


LAKE
190
188
186
184
182
180
178
176
174
172
170
168
166
164
162
160
Sta. 11+85
80'
CREEK
End Guard Rail 20+25 R
Guard Rails - V.D.H. Std. GR-2
CORE See Specifications
102'-72" CONC PIP CLASS III
POND
2:1 SLOPE
N15°42'50"W
1624.92'
End Guard Rail 20+15 L
102.64'
N52°52'30"E
Post
N62°16'W
Property Line
366.48'
BEAVER
Constructed Channel 12' Wide and 2' deep.

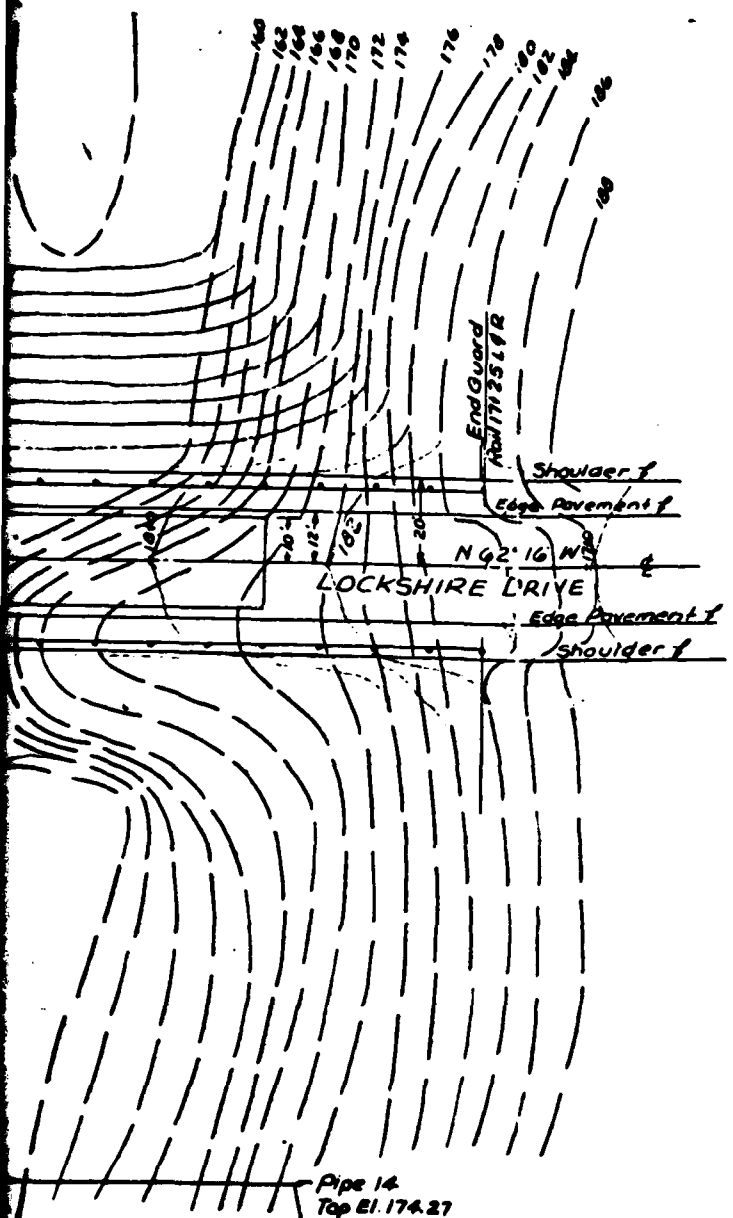


PLATE No 2

LOWER LAKE BEXLEY
LAKE GEORGE DAM

Manchester Dist, Chesterfield Co, Va.

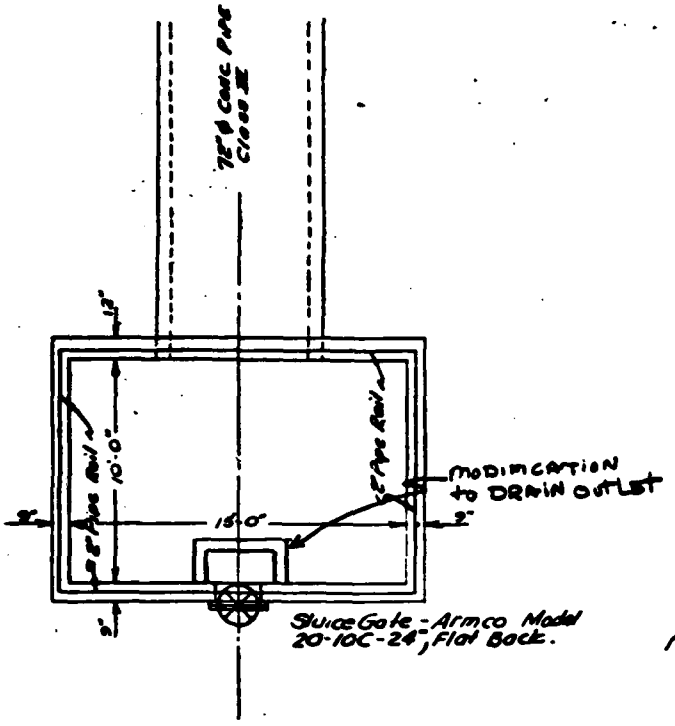
Revised August 26, 1968 Scale: 1" = 20'

La Prade Bros.
Civil Engineers & Surveyors
Richmond, Virginia

Sheet 2 of 7

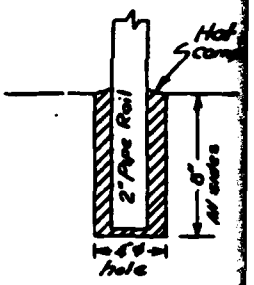
INTAKE WEIR BOX

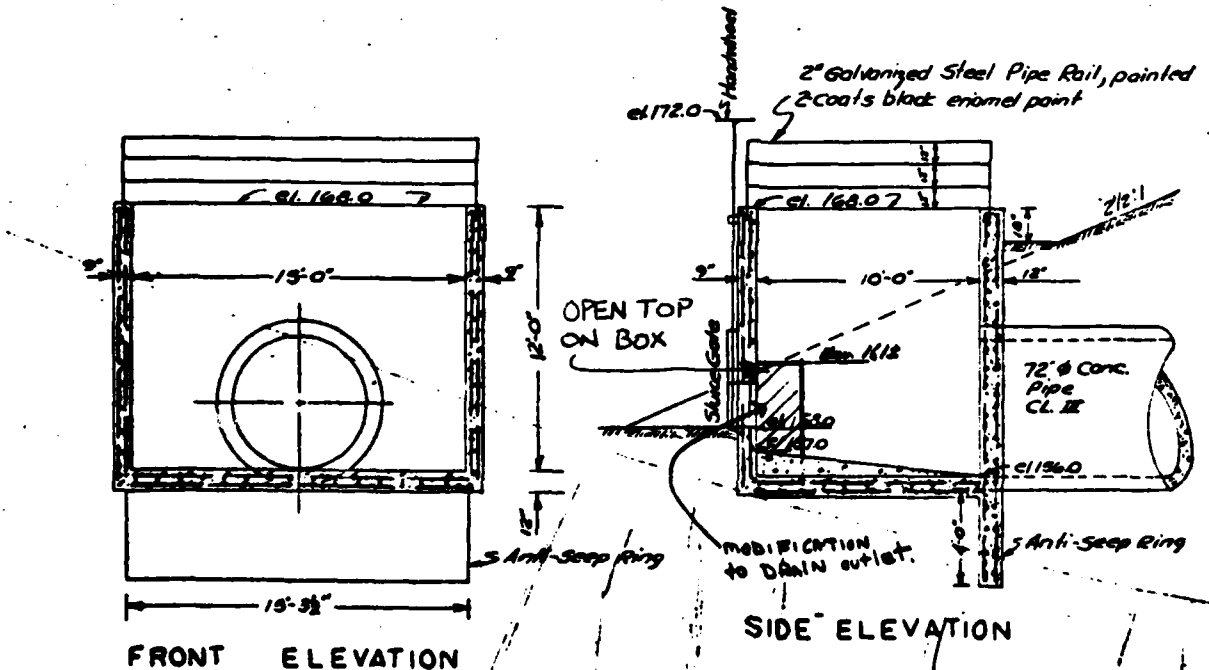
SCALE 1/4" = 1'



PLAN VIEW

Note: Reinforcement for intake weir box see Sheet No. 4 of 7 for size of ϕ bars and spacing.



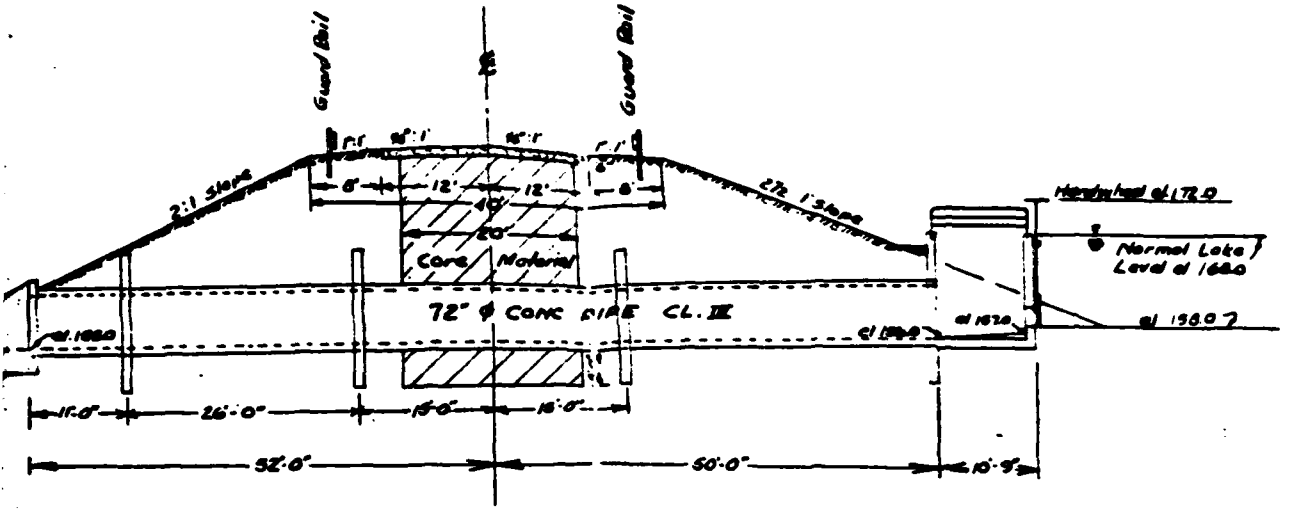


Wing Wall standard
YORK-ENK-2

Percent Finer by Weight

Chart sho
for use in

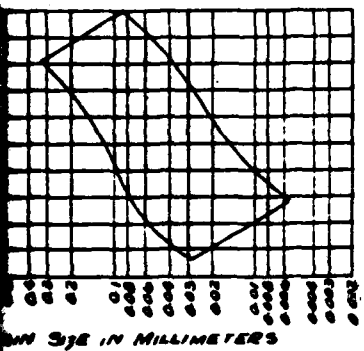
24" x 6" Aggregate Base Material
24" - Prime & Double Seal Surface



SECTION @ STATION 18+85
1" = 10'
(Facing West)

ured lead to
ely fill hole.

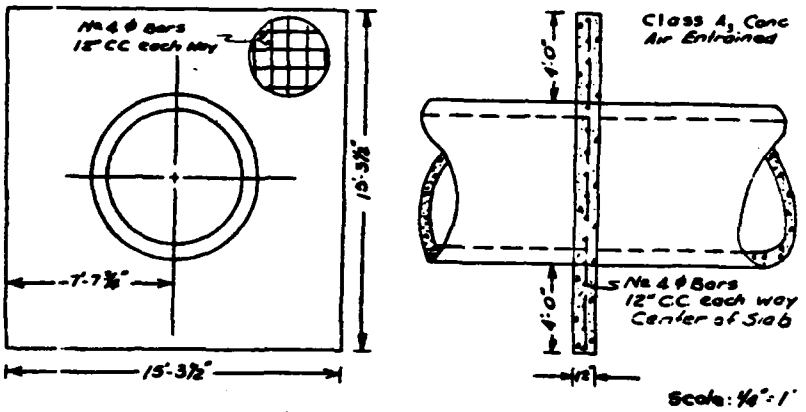
DETAIL - PIPE
RAIL MOUNTING



N SIZE IN MILLIMETERS

Shaded area is limit of acceptable core material

g grain sizes of material acceptable
e Wall.



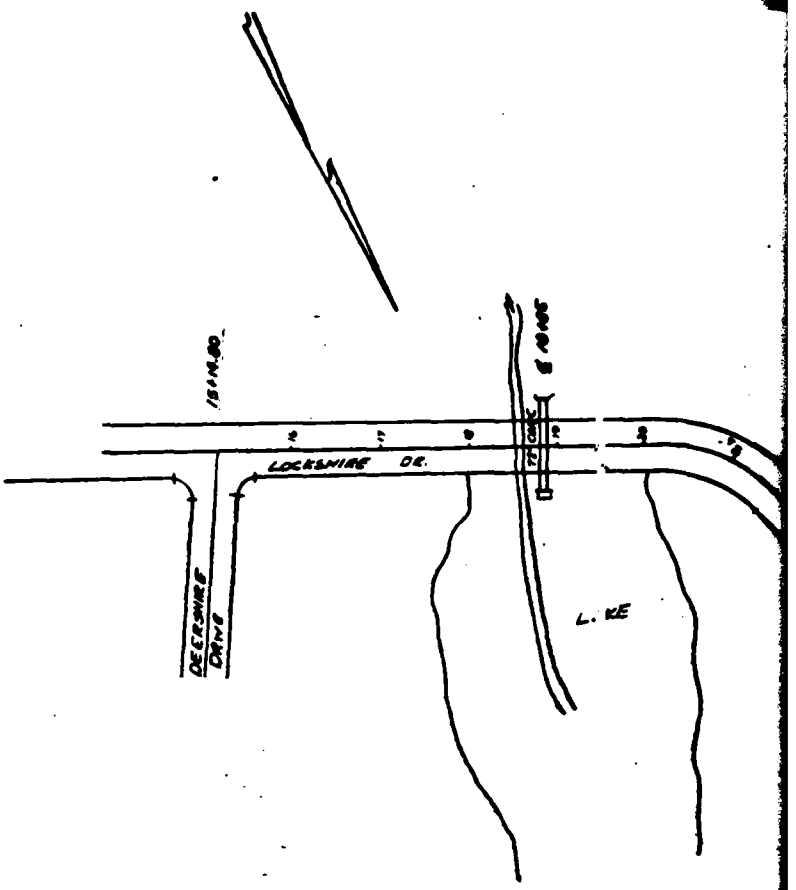
DETAILS ANTI-SEEP RINGS

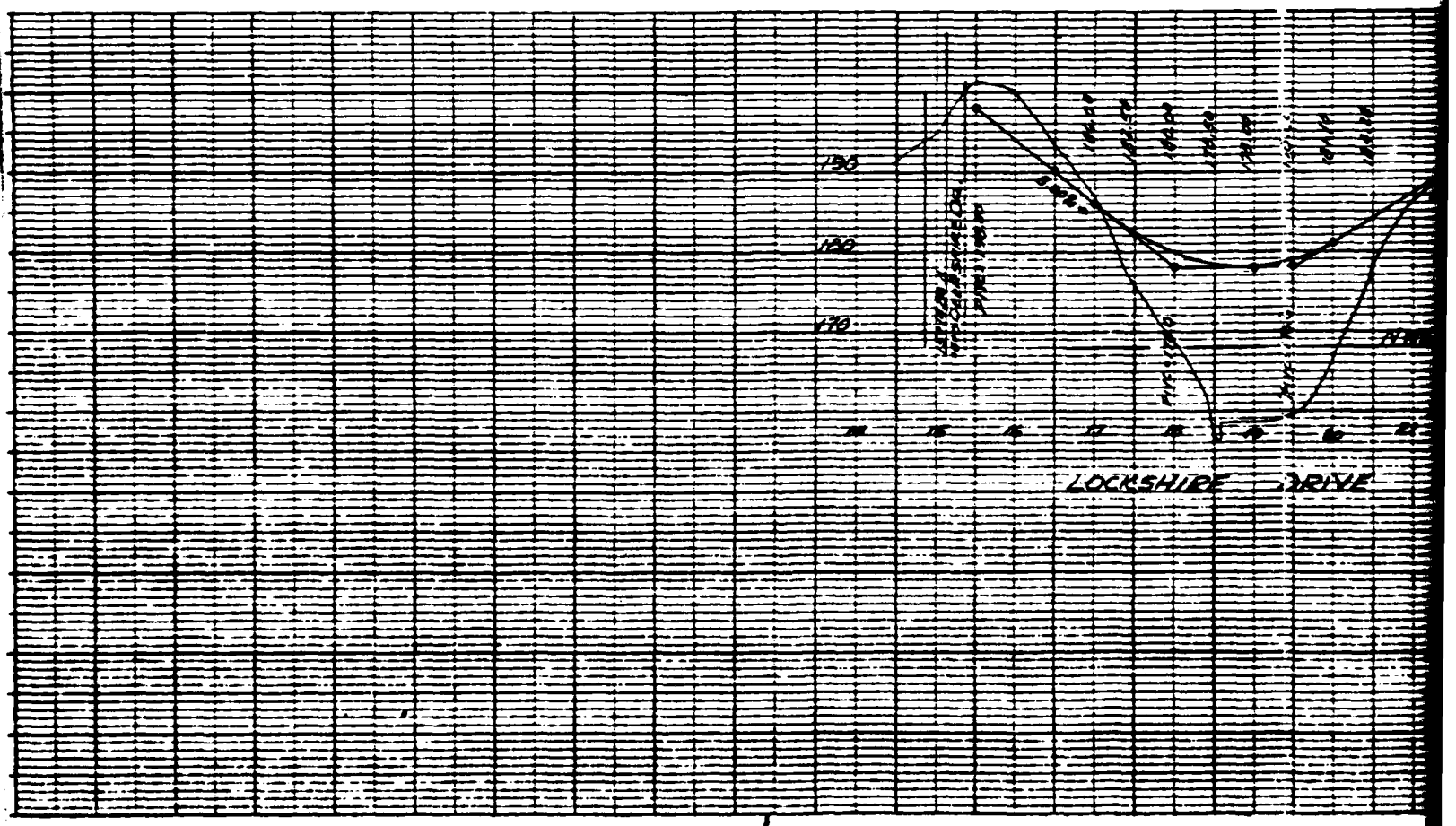
PLATE No 3

LAKE GEORGE DAM
LOWER LAKE BEXLEY
Manchester District
Chesterfield County, Va.

Revised August 26, 1968

La Prade Bros.
Civil Engineers & Surveyors
Richmond, Virginia


LOCKSHIRE DR.
DEERSHIRE DRIVE
L. KE


LOCKSHIRE DRIVE

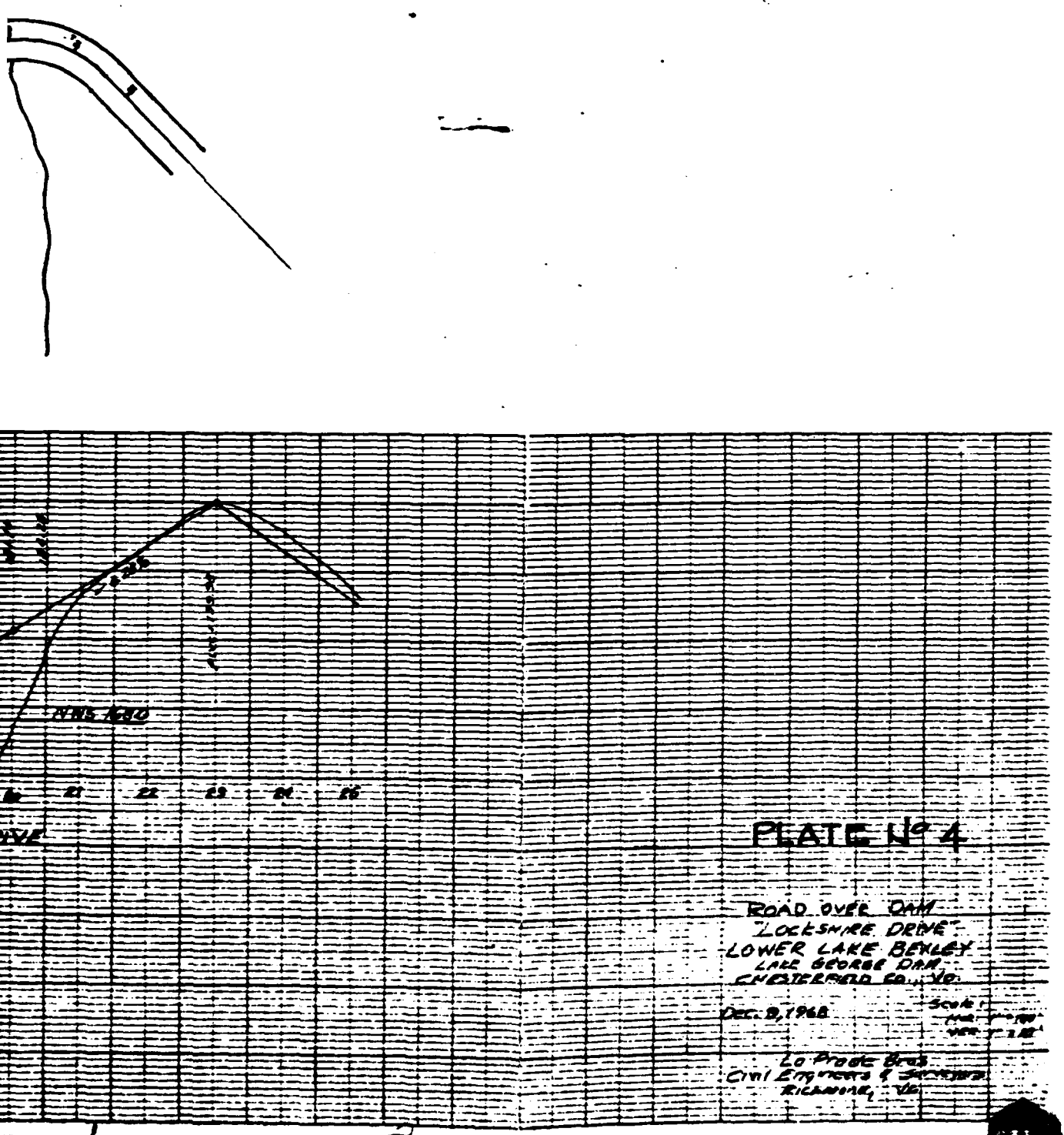


PLATE No 4
ROAD OVER DAM
"LOCKSHIRE DRIVE"
LOWER LAKE BEKLEY
LAKE GEORGE DAM
CHESTERFIELD CO., VA.
Dec. 9, 1968
Scale:
Hor. 1" = 100'
Ver. 1" = 10'
LO Proctor Bros
Civil Engineers & Surveyors
Richmond, Va.

APPENDIX II

PHOTOGRAPHS

Photo No. 1

Overflow wier and upstream face of dam

Photo No. 2

Downstream face of dam

Photo No. 3

72 inch outlet pipe at overflow wier structure

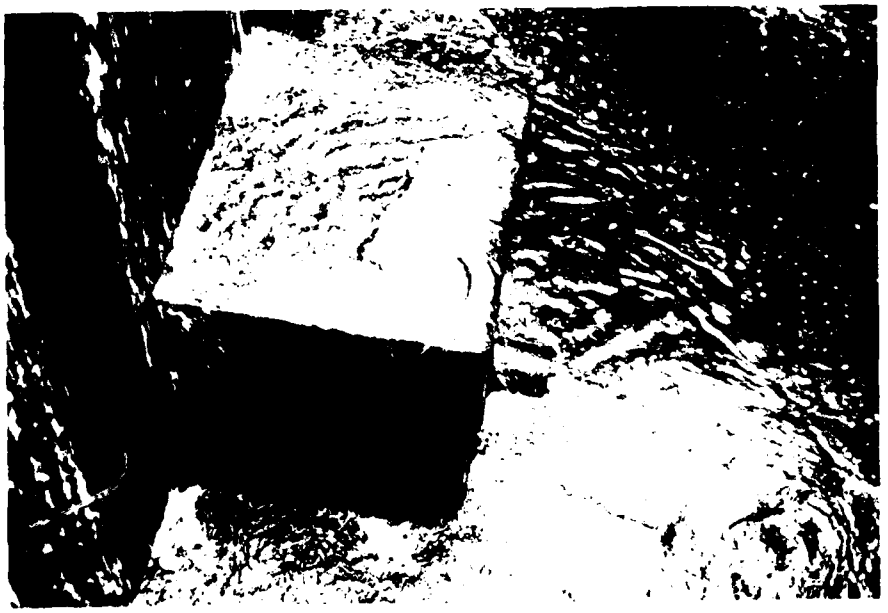


Photo No. 4

Concrete box modification to drain outlet
(Note Open Top)

Photo No. 5

72 inch outlet pipe at Plunge Pool

Photo No. 6

Downstream Channel
(Arrow Denotes Channel)

Photo No. 7

Sloughing of bank at Plunge Pool

Photo No. 8

Sediment buildup in Plunge Pool
(Arrow denotes sand bar which developed
during October 1979 flood)

APPENDIX III

FIELD OBSERVATIONS

Check List
Visual Inspection
Phase I

Name Dam Lower Beaver Pond County Chesterfield State Virginia Coordinates Lat 37° 27.2' Long 77° 34.1'

Date(s) Inspection May 29, 1980 Weather Fair Temperature 75°F±

Pool Elevation at Time of Inspection 168.2 msl Tailwater at Time of Inspection 156 msl

Inspection Personnel:

Schnabel Engineering Associates, P.C.
Raymond A. DeStephen, P.E.*
Stephen G. Werner (recorder)

J. K. Timmons and Associates, Inc.
Robert G. Roop, P.E.
Donald Balzer (recorder)

State Water Control Board
Leon Musselwhite
Dave Bushman

Wallace H. LaPrade, Owner

* Not present during May 29, 1980 inspection, but inspected on July 16, 1980. The weather was fair and hot with a high of 90°F±. Pool and tailwater levels were essentially the same as reported above.

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	The slopes, crest and abutment contacts were inspected and no cracks were noted. The downstream slope was covered with tall grass (3 ft ± high). Half inch (½) to 2 inches diameter trees were growing along and just above pool level on the upstream slope and on the downstream slope around the outlet.	The grass on the embankment was cut and well maintained during the July 16, 1980 inspection. Trees were still in place and should be removed.
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None observed	-
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	An eroded area exists along the left abutment. A field sketch is included as Sheet 1. Exposed embankment soils consist of dry fine to coarse sand, some silt to clayey silt, trace mica. Appears to be road base material. The dam was constructed with clay soils cut from surrounding roads according to Mr. Wallace. Upstream slope is 3H:1V and downstream slope is 2.5H:1V.	The eroded area should be repaired.
VERTICAL AND HORIZONTAL ALINEMENT OF THE CREST	Appeared to be good.	-
RIPRAP FAILURES	Scattered riprap was exposed along the upstream slope from pool level to a point 3 ft± above. The riprap appears to be discontinuous. Vegetation and washing of soils may conceal portions of the riprap, making it appear to be discontinuous. Riprap is up to 2½ ft± long and consists of granite.	Riprap appears to be functioning properly since very little erosion of the upstream slope was observed at and above pool level.

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	No bedrock was exposed at the site. The embankment ties in well with abutments and no erosion was noted at their contacts. Local geology appears to consist of Pleistocene terrace deposits (assorted combinations of sand, silt, clay and gravel) overlying the Petersburg Granite. No faults were encountered during the inspection The natural abutments appear to slope rapidly and the old stream valley was probably steep and narrow.	
ANY NOTICEABLE SEEPAGE	No seepage was noted	-
STAFF GAGE AND RECORDER	None observed	A staff gage should be installed.
DRAINS	None observed	If any exist, they were submerged.

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	None	-
INTAKE STRUCTURE	Concrete was in good condition and no spalling noted. Weir box is 10 ft x 15 ft. Back of weir is 12 ft high. Overflow is on four sides. Some debris present around intake structure.	Debris should be removed.
OUTLET STRUCTURE	72 inch ± concrete pipe with headwall.	Concrete is in good condition.
OUTLET CHANNEL	Some sloughing was noted along the banks of the plunge pool. See field sketch, Sheet 1. Some debris and sediment buildup was observed in the pool.	Erosion occurred during a storm in October 1979. Sloughing should be corrected and the debris should be removed.
EMERGENCY DRAINS	Operable draingate. No emergency spillway.	-

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Slight to moderate slopes (3H:1V average) bound the reservoir. No bank erosion was noted. The area is heavily wooded and includes variable amounts of underbrush. The extreme upstream area is bounded by open fields. Reservoir is free of debris.	Good condition
SEDIMENTATION	None observed	Good condition

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Very little debris present in the channel.	Good condition
SLOPES	The stream channel is 10 ft$^{\pm}$ wide, 3 ft$^{\pm}$ deep and includes 1H:1V side slopes. Flood plain is 300 ft$^{\pm}$ wide and is wooded and includes underbrush. N = 0.1	-
APPROXIMATE NO. OF HOMES AND POPULATION	Approximately 1/2 mile downstream there are two homes whose basement floors are 10 ft$^{\pm}$ above the stream.	-

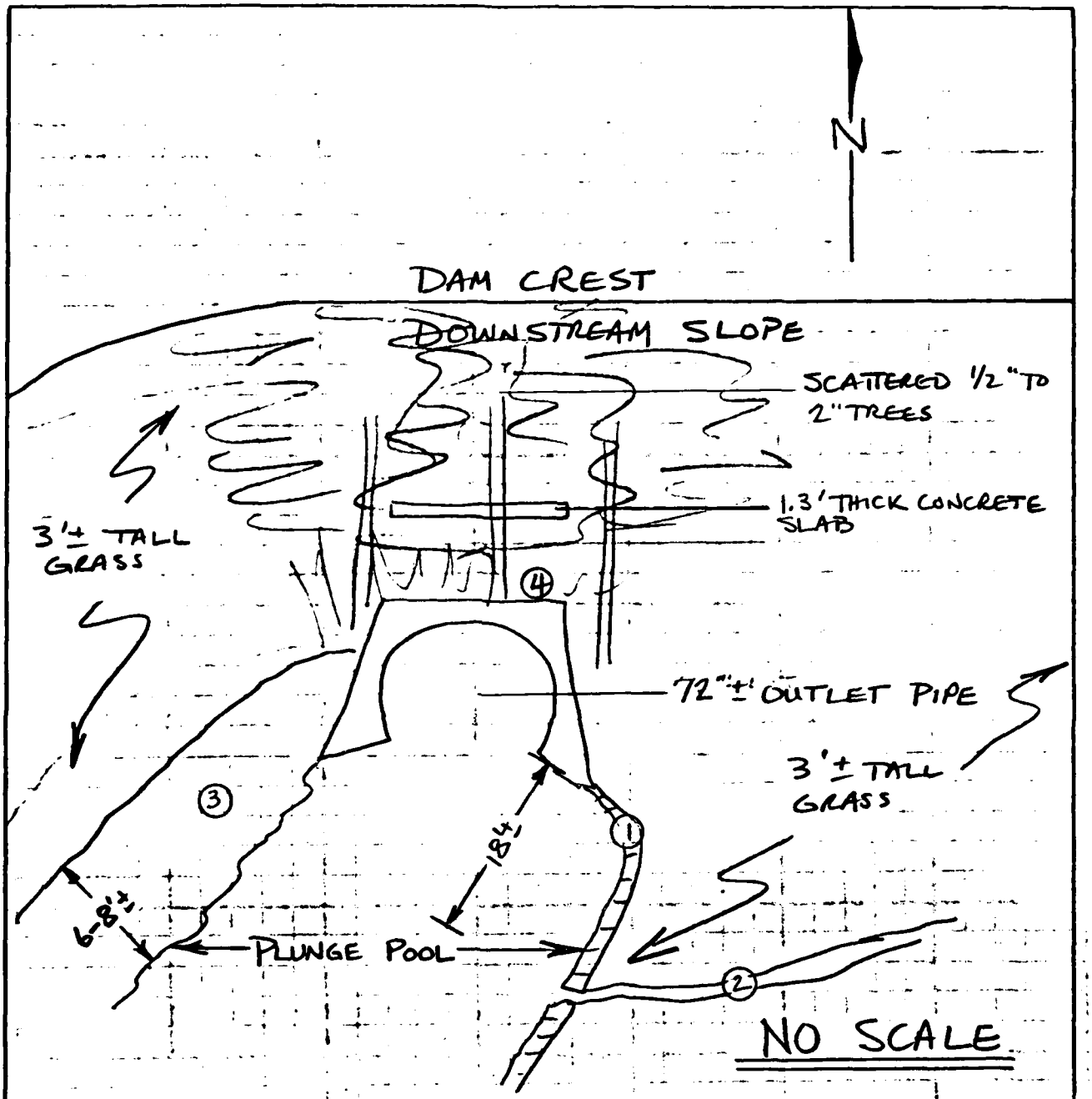
INSTRUMENTATION

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None	-
OBSERVATION WELLS	None	-
WEIRS	None	-
PIEZOMETERS	None	-
OTHER		

BY SW DATE 5/29/80 | SCHNABEL ENGINEERING ASSOCIATES CONSULTING ENGINEERS | SHEET NO. 1 OF 2

CHKD. BY ____ DATE ____ | JOB NO. V79486

SUBJECT FIELD SKETCH OF ERODED AREAS



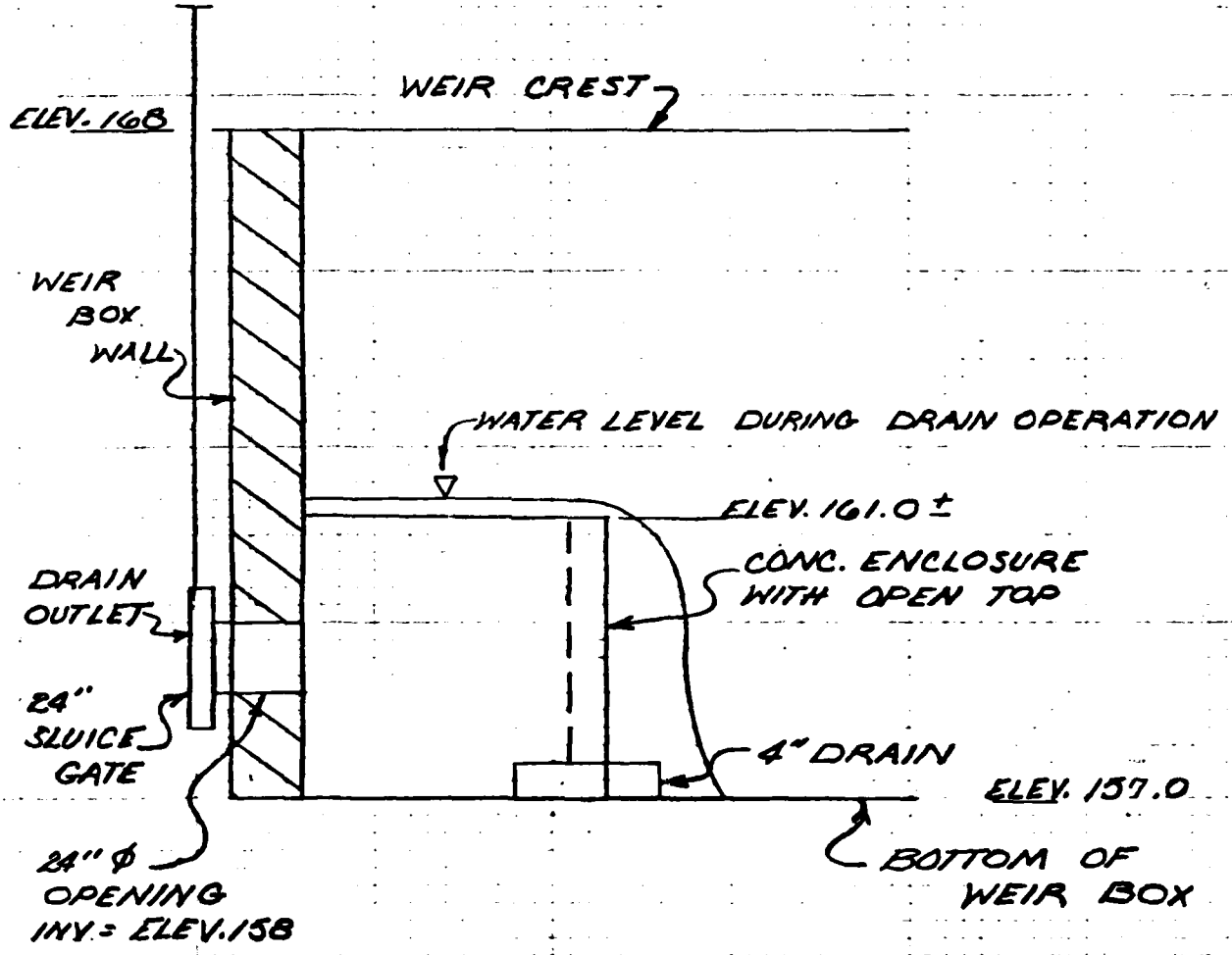
① 1' TO 3'± DROP FROM EDGE OF SLOPE TO POOL

② EROSIONAL GULLEY 1' TO 2' WIDE AND 1' TO 3' DEEP. EXTENDS 65' TO 75'± UPSLOPE TOWARD THE LEFT ABUTMENT

③ BARE, VERY STEEP SLOPE WITH SCATTERED SURFACE WASHING

④ SOIL AND BOULDERS (UP TO 5'± LONG) FILL OVER TOP OF OUTLET STRUCTURE. SEVERAL ANIMAL BURROWS PRESENT

LOWER BEAVER POND DAM
FIELD SKETCH
DRAIN OUTLET MODIFICATION



SECTION THROUGH WEIR BOX

N.T.S.

J.N. 13062

APPENDIX IV

TEST BORING LOGS

SINCE
1881

FROEHLING & ROBERTSON, INC.
INSPECTION ENGINEERS • CHEMISTS • BACTERIOLOGISTS
CABLE ADDRESS—"FROEHLING"

MAIN OFFICE AND LABORATORIES
P. O. BOX 737, 814 WEST CARY STREET
RICHMOND, VIRGINIA 23206
PHONE 644-3052

BRANCH LABORATORIES
NORFOLK, CHARLOTTE, RALEIGH
WASHINGTON, BALTIMORE
GREENVILLE, ROANOKE, FAYETTEVILLE
ASHEVILLE

Richmond, Virginia
December 8, 1967

Record No. R-2169-11

Report of: Soil Borings

Made for: Mr. Wallace LaPrade
c/o LaPrade Bros. Engineers
103 East Cary Street
Richmond, Virginia

Attn: Mr. Carl Watkins

Project: Lake George Hamlet Dam LOWER DAM

Location: Route 360 at Falling Creek
Chesterfield Co., Va.

0-0-0

Upon authorization from Mr. Carl Watkins of LaPrade Bros., test borings were made at site as shown on enclosed sketch.

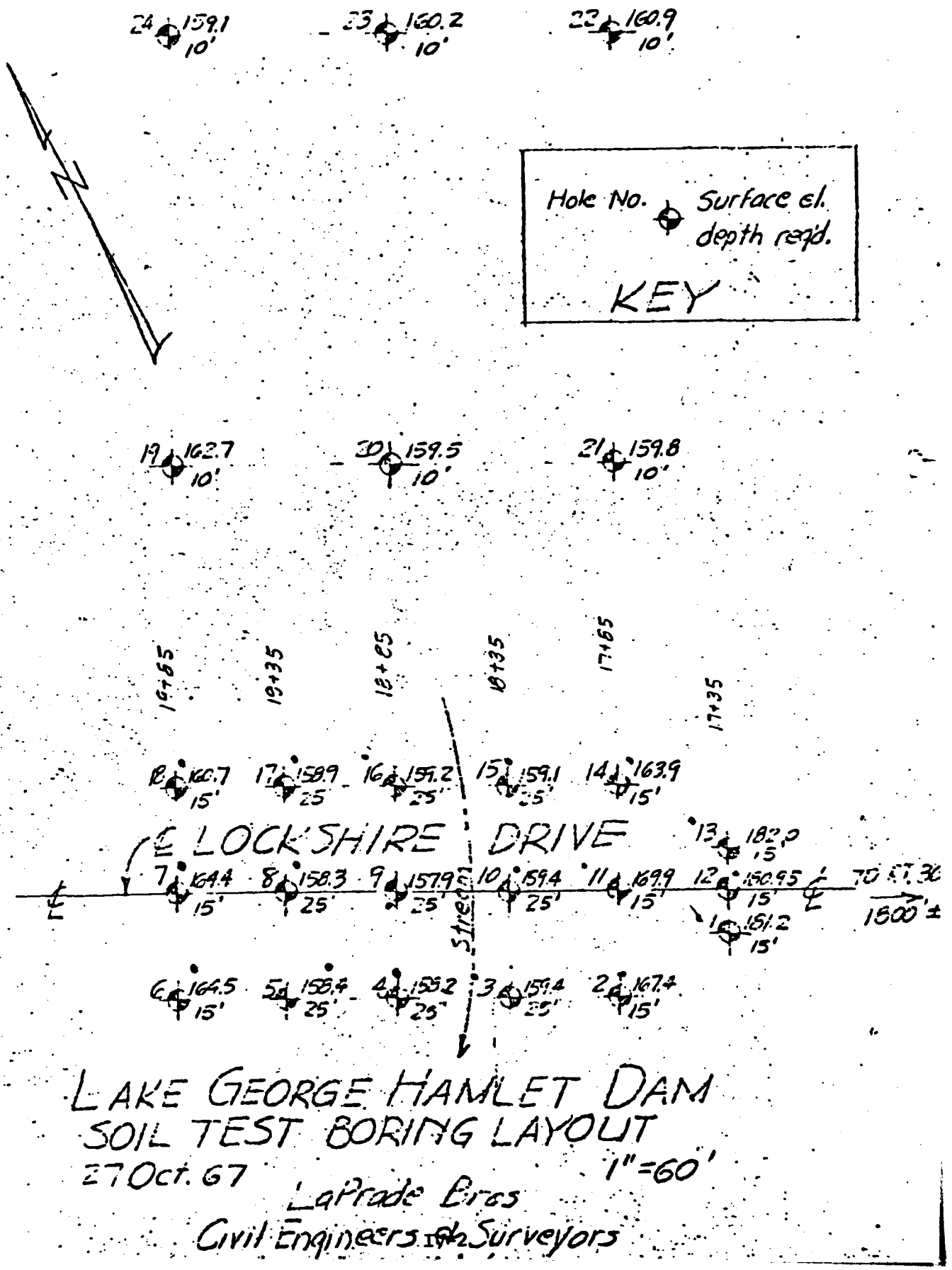
The test borings were made by means of drive sample borings, auger boring and diamond core drilling. The penetration resistance of the soil was determined by means of the standard penetration test at each change in strata or at five foot intervals, whichever occurs first. In the standard penetration test a 140 lb. hammer dropping 30" is used to drive a 2"O.D. 1.375"I.D. split spoon sampler 1 foot into the soil. The results of the tests are shown in the following boring logs.

Very truly yours,

FROEHLING & ROBERTSON, INC.

W. H. Vogelsang, Director
Foundation Investigation

WHV/gm



LAKE GEORGE HAMLET DAM
SOIL TEST BORING LAYOUT

27 Oct. 67

1"=60'

LaPrade Bros
Civil Engineers & Surveyors

SO-SA

BORING LOG

SINCE F&R 1881 **FROEHLING & ROBERTSON, INC.**
INSPECTION ENGINEERS • CHEMISTS • BACTERIOLOGISTS

Report No. R-2169-II DATE December 8, 1967

Made for: Mr. Wallace LaPrade c/o LaPrade Bros. Engineers

Project: Lake George Hamlet Dam, Route 360 & Falling Creek, Chesterfield Co., Va.

Hole No.: 7 | Total Depth: 15.0 | Elevation—Top of Hole: 164.4 | Hole Location:

Type of Boring: 2½" Casing | Started 12/2/67 | Completed 12/2/67 | Driller: H. Watts

Elevation	Depth	Casing Blows	CLASSIFICATION OF MATERIALS (Description)	Sample Blows	% Core Recovery	REMARKS
164.4	0.0					
			Brown Micaceous Silt		2.0	Water Data:
161.4	3.0			12	3.0	5.7' @ 0 hr
					4.0	
			Tan Decomposed Rock	100	5.0	
155.4	9.0					Note: Core Drilled
154.4	10.0		Tan Granite Boulders		100%	Granite Boulder
			Tan Micaceous Silt		14.0	
149.4	15.0			48	15.0	
			Boring Terminated			

SO-5A

BORING LOG

SINCE F&R 1881 **FROEHLING & ROBERTSON, INC.**
INSPECTION ENGINEERS • CHEMISTS • BACTERIOLOGISTS

Report No. R-2169-11 DATE December 8, 1967

Made for: Mr. Wallace LaPrade c/o LaPrade Bros. Engineers

Project: Lake George Hamlet Dam, Route 360 & Falling Creek, Chesterfield Co., Va.

Hole No.: 8 | Total Depth: 6.0 | Elevation—Top of Hole: 158.3 | Hole Location:

Type of Boring: 2½"Casing 2"Dia.Bit | Started 12/1/67 | Completed 12/1/67 | Driller: H. Watts

Elevation	Depth	* Casing Blows	CLASSIFICATION OF MATERIALS (Description)	** Sample Blows	% Core Recovery	REMARKS
158.3	0.0		Brown Organic Silt		2.0	Water Data: 1.7' @ 0 hr
				4	3.0	
155.3	3.0		Gray Fine Silty Sand	6	4.0	Started Core Drilling
154.3	4.0		Gray Granite		75%	4.0' with 2" Diamond Bit
152.3	6.0		Boring Terminated			

SO-5A

BORING LOG

SINCE F&R 1881 **FROEHLING & ROBERTSON, INC.**
INSPECTION ENGINEERS • CHEMISTS • BACTERIOLOGISTS

Report No. R-2169-11 DATE December 8, 1967

Made for: Mr. Wallace LaPrade c/o LaPrade Bros. Engineers

Project: Lake George Hamlet Dam, Route 360 & Falling Creek, Chesterfield Co., Va.

Hole No.: 9 | Total Depth: 22.0 | Elevation—Top of Hole: 157.9 | Hole Location: .

Type of Boring: 2½"CASING 2"Dia.Bit | Started 11/29/67 | Completed 11/29/67 | Driller: H. Watts

Elevation	Depth	Casing Blows	CLASSIFICATION OF MATERIALS (Description)	Sample Blows	% Core Recovery	REMARKS
157.9	0.0					Water Data:
			Brown Clayey Silt		2.0	1.5' @ 0 hr
				5	3.0	
154.4	3.5				4.0	
				8	5.0	
			Gray Silty Clay			
148.9	9.0				9.0	
				37	10.0	
			Brown Micaceous Silt, Trace of Decomposed Rock			
					14.0	
				70	15.0	
					19.0	
				100	19.5	
137.9	20.0					Started Core Drilling
			Gray Granite & Quartz		75%	20.0' with 2" Diamond Bit
135.9	22.0		Boring Terminated			

SO-5A

BORING LOG

SINCE F&R 1881 **FROEHLING & ROBERTSON, INC.**
INSPECTION ENGINEERS • CHEMISTS • BACTERIOLOGISTS

Report No. R-2169-11 DATE December 8, 1967

Made for: Mr. Wallace LaPrade c/o LaPrade Bros. Engineers

Project: Lake George Hamlet Dam, Route 360 & Falling Creek, Chesterfield Co., Va.

Hole No.: 10 | Total Depth: 25.0 | Elevation-- Top of Hole: 159.4 | Hole Location:

Type of Boring: 2½"Casing 2"Dia.Bit | Started 11/27/67 | Completed 11/28/67 | Driller: H. Watts

Elevation	Depth	Casing Blows	CLASSIFICATION OF MATERIALS (Description)	Sample Blows	% Core Recovery	REMARKS
159.4	0.0					
			Brown Clayey Silt		2.0	Water Data:
				10	3.0	3.1' @ 0 hr
155.4	4.0				4.0	
				10	5.0	
			Gray Medium Sand & Small Gravels			
					9.0	
				34	10.0	
147.9	11.5					
			Brown to Gray Micaceous Silt,		14.0	
			Trace of Decomposed Rock	100	15.0	
					19.0	
				53	20.0	
136.6	22.8					Started Core Drilling 22.8' with 2" Diamond Bit
			Gray Granite		100%	
134.4	25.0		Boring Terminated			

SO-5A

BORING LOG

SINCE F&R 1881 **FROEHLING & ROBERTSON, INC.**
INSPECTION ENGINEERS • CHEMISTS • BACTERIOLOGISTS

Report No. R-2169-11 DATE December 8, 1967

Made for: Mr. Wallace LaPrade c/o LaPrade Bros. Engineers

Project: Lake George Hamlet Dam, Route 360 & Falling Creek, Chesterfield Co., Va.

Hole No.: 11 | Total Depth: 15.0 | Elevation—Top of Hole: 169.9 | Hole Location: .

Type of Boring: 2½" Casing | Started 11/22/67 | Completed 11/22/67 | Driller: H. Watts

Elevation	Depth	Casing Blows	CLASSIFICATION OF MATERIALS (Description)	Sample Blows	% Core Recovery	REMARKS
169.9	0.0					
			Brown Micaceous Silt		2.0	
				8	3.0	
					4.0	
				5	5.0	
160.9	9.0				9.0	
			Gray Organic Sandy Silt	3	10.0	
157.6	12.3		Gray Granite Boulder			
157.2	12.7					
			Gray Decomposed Rock		14.0	
154.9	15.0			10	15.0	
			Boring Terminated			

SO-SA

BORING LOG

SINCE F&R 1881 **FROEHLING & ROBERTSON, INC.**
INSPECTION ENGINEERS • CHEMISTS • BACTERIOLOGISTS

Report No. R-2169-11 DATE December 8, 1967

Made for: Mr. Wallace LaPrade c/o LaPrade Bros. Engineers

Project: Lake George Hamlet Dam, Route 360 & Falling Creek, Chesterfield Co., Va.

Hole No.: 12 | Total Depth: 15.0 | Elevation—Top of Hole: 180.95 | Hole Location:

Type of Boring: 2½" Casing | Started 11/21/67 Completed 11/21/67 | Driller: H. Watts

Elevation	Depth	Casing Blows	CLASSIFICATION OF MATERIALS (Description)	Sample Blows	% Core Recovery	REMARKS
180.95	0.0					
			Tan Micaceous Silt		2.0	
177.95	3.0			12	3.0	
					4.0	
				37	5.0	
			Brown Decomposed Rock			
					9.0	
				57	10.0	
					14.0	
165.95	15.0			34	15.0	
			Boring Terminated			

APPENDIX V

LABORATORY TEST DATA

FROEHLING & ROBERTSON, INC.
INSPECTION ENGINEERS • CHEMISTS • BACTERIOLOGISTS
CABLE ADDRESS—"FROEHLING"
1881

MAIN OFFICE AND LABORATORIES
P. O. BOX 737, 814 WEST CARY STREET
RICHMOND, VIRGINIA 23206
PHONE 644 2035

BRANCH LABORATORIES
NORFOLK, CHARLOTTE, RALEIGH
WASHINGTON, BALTIMORE
GREENVILLE, ROANOKE, FAYETTEVILLE
ASHEVILLE

RICHMOND, VIRGINIA
NOVEMBER 21, 1967-

Record No: R-1399-11
Report Of: Soil Tests
Made For : La Prade Brothers
3 West Cary Street
Richmond, Virginia
Attn: Mr. Carl Watkins

0-0-0

Tests were performed on a combination of 5 bag samples.

		S-1	S-2
Passing No. 4	Sieve	100.0	100.0
Passing No. 10	Sieve	99.2	99.6
Passing No. 20	Sieve	93.8	95.2
Passing No. 40	Sieve	86.7	88.9
Passing No. 60	Sieve	79.8	83.1
Passing No. 100	Sieve	70.6	73.5
Passing No. 140	Sieve	63.9	66.7
Passing No. 200	Sieve	58.7	62.1
Passing No. 270	Sieve	56.7	61.0
Liquid Limit		25.7	24.4
Plasticity Index		6.2	5.1
Gravel (Plus No. 10)		0.8	0.4
Coarse Sand (No. 10-No. 40)		12.5	10.7
Fine Sand (No. 40-NO. 200)		28.0	26.8
Silt No. 200- 0.005 mm)		40.7	45.1
Clay (-0.005 mm)		18.0	17.0

Respectfully,

FROEHLING & ROBERTSON, INC.

ljp

4cc: La Prade Brothers

these two samples are from blend of 5 bag samples dug by Wallace LaP just below Upper Dam @ Lake Geo. Hamlet on 16 Nov. 67 caw

FROEHLING & ROBERTSON, INC.
INSPECTION ENGINEERS • CHEMISTS • BACTERIOLOGISTS
CABLE ADDRESS—"FROEHLING"
1881

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ASHEVILLE

RICHMOND, VIRGINIA
DECEMBER 4, 1967

Record No: R-1399-12
Report Of: Soil Tests
Made For : La Prade Brothers
3 West Cary Street
Richmond, Virginia
Attn: Mr. Carl Watkins
Project : Dam No. 1 (LOWER DAM)

0-00-0

	H-1B S-1	H-2B S-1 0-10'	H-2A S-1 0-3'	H-21 S-2	H-22 S-1 0-7'
Passing No. 4 Sieve	100.0	100.0	100.0	100.0	100.0
Passing No. 10 Sieve	95.5	96.7	96.8	96.2	99.2
Passing No. 20 Sieve	76.8	83.7	83.3	83.0	93.7
Passing No. 40 Sieve	57.0	67.7	65.8	69.2	87.8
Passing No. 60 Sieve	44.5	52.8	54.5	58.7	83.3
Passing No. 100 Sieve	33.5	42.3	46.0	50.8	80.5
Passing No. 140 Sieve	28.3	36.3	42.3	46.0	77.5
Passing No. 200 Sieve	23.5	32.0	39.3	42.0	74.3
Liquid Limit	31.0	24.3	26.2	29.5	31.6
Plasticity Index	N.P.	N.P.	2.1	N.P.	9.0
Gravel (Plus No. 10)	4.5	3.3	3.2	3.8	0.8
Coarse Sand (No. 10-No. 40)	38.5	29.0	31.0	27.0	11.4
Fine Sand (No. 40 - No. 200)	33.5	35.7	26.5	27.2	13.5
Silt (No. 200 - 0.005 MM)	15.5	21.0	27.3	29,0	45.3
Clay (- 0,005 MM)	8.0	11.0	12.0	13.0	29.0

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	H-22 S-2 7'-10'	H-23 S-1 1'-10'	H-24 S-1 0'-7'-	H-24 S-2 7'-10'
Passing No. 4 Sieve	98.3	99.8	99.3	100.0
Passing No. 10 Sieve	95.5	94.5	95.8	99.3
Passing No. 20 Sieve	91.8	91.0	84.0	90.0
Passing No. 40 Sieve	84.0	56.3	71.7	75.7
Passing No. 60 Sieve	66.8	44.7	57.3	61.0
Passing No. 100 Sieve	54.7	36.3	41.2	48.7
Passing No. 140 Sieve	48.3	32.5	32.5	41.5
Passing No. 200 Sieve	43.8	29.3	26.7	36.0
Liquid Limits	20.9	26.0	26.0	39.2
Plasticity Index	N.P.	4.5	N.P.	N.P.
Gravel (Plus No. 10)	4.5	5.5	4.2	0.7
Coarse Sand (No. 10 - No. 40)	11.5	38.2	24.1	23.6
Fine Sand (No. 40 - No. 200)	40.2	27.0	45.0	39.7
Silt (No. 20- 0.005 MM)	26.8	19.3	17.7	28.0
Clay (- 0.005 MM)	17.0	10.0	9.0	8.0

Respectfully,

FROEHLING & ROBERTSON, INC.

/jp

4cc: La Prade Brothers

APPENDIX VI - REFERENCES

1. Recommended Guidelines for Safety Inspection of Dams, Department of Army, Office of the Chief of Engineers, 46 pp.
2. Design of Small Dams, U. S. Department of Interior, Bureau of Reclamation, 1974, 816 pp.
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4. Geology of the Studley, Yellow Tavern, Richmond and Seven Pines Quadrangles, Virginia by P. A. Daniels, Jr. and Emil Onuschak, Jr., 1974, 75 pp.
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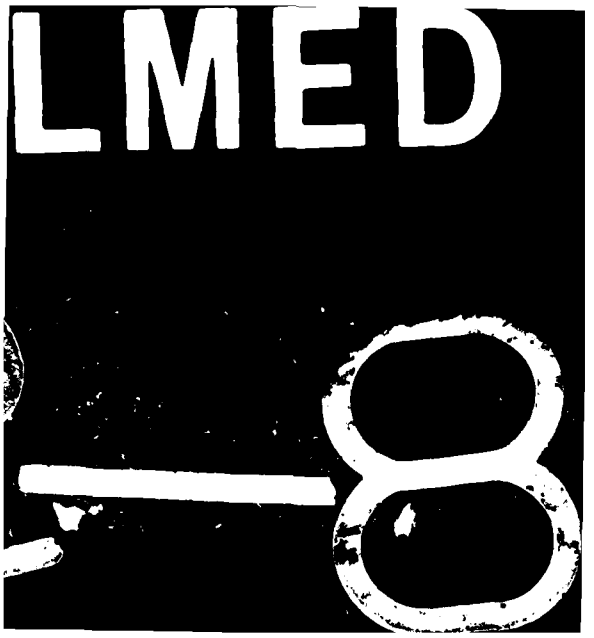
6. Hydrometerological Report No. 33, U. S. Department of Commerce, Weather Bureau, U. S. Department of Army, Corps of Engineers, Washington, D. C., April 1956.
7. Technical Paper No. 40, U. S. Department of Commerce, Weather Bureau, Washington, D. C., May 1961.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